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Fisher's linear discriminant ratio based threshold for moving human detection in thermal video

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HIGHLIGHTS

- To develop a Fisher's linear discriminant ratio based threshold for pixel classification.
- To preserve the class discriminatory information using Fisher's linear discriminant analysis.
- To present an idea to find an optimal directions along which two classes are well separated.
- To identify and detect moving human in thermal video.

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ABSTRACT

In video surveillance, the moving human detection in thermal video is a critical phase that filters out redundant information to extract relevant information. The moving object detection is applied on thermal video because it penetrate challenging problems such as dynamic issues of background and illumination variation. In this work, we have proposed a new background subtraction method using Fisher's linear discriminant ratio based threshold. This threshold is investigated automatically during run-time for each pixel of every sequential frame. Automatically means to avoid the involvement of external source such as programmer or user for threshold selection. This threshold provides better pixel classification at run-time. This method handles problems generated due to multiple behavior of background more accurately using Fisher's ratio. It maximizes the separation between object pixel and the background pixel. To check the efficacy, the performance of this work is observed in terms of various parameters depicted in analysis. The experimental results and their analysis demonstrated better performance of proposed method against considered peer methods.

1. Introduction

Since last decade, the video surveillance system is a highly progressive research topic due to day to day's importance for security aspect in public or private areas. The visual surveillance system is a challenging research area of computer vision. It is an important technology that deals with various terrorism activities, public safety and traffic management [1–4]. An automated surveillances system mainly consists of the object detection, object classification, object tracking, behavior recognition, activity analysis and pragmatic description [3,5]. In surveillance system, the detection of moving object is the first initial step of various image analysis applications such as human machines interaction, indexing of video data and tracking of the object.

The surveillance system mainly involves a static camera and dynamic background that provides a basic idea for detection of moving object in video [6,7]. There are numerous approaches through which object detection can be done such as background subtraction, active contour model, Hough transformation, optical flow and filtering techniques such as kalman or median filter. Among all of them video sequences are generally carried out using a popular approach known as the background subtraction with fixed camera and static background. In the above scenario, the moving object can be detected by comparing current video frame with the background. But most of the cases suffers from false alarms, means detected object is followed with background that are misclassified because of the environmental or illumination effect in the background frame [8–10]. Sometimes, slow movement of leaves, shadow, and occlusion are detected as foreground during

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the object detection procedure. To overcome such issues some additional steps are carried out for improvement. For effective object detection, misclassified pixels can be easily removed using morphological operations such as erosion and dilation.

1.1. Real-time applications and advantages of thermal video surveillance

The infrared imaging can be applied for security-surveillance systems like surveillance of border, sea, port, city, traffic, or a wide range of police applications. The proposed method also enables a coastguard to monitor large stretches of waterway and coastline for detection of smuggling, illegal intrusion or fishing, etc. [11–13]. Some of the real-time surveillance related research areas [14–17] also mentioned here.

- The investigator, police and other agents use this work with live as well as recorded motion imagery. This area assist them to monitor gang networks, spikes in crime, drug houses and to track violent crime patterns.
- To identify and detect the suspect behind foliage in poor visibility or darkness.
- To identify, detect and track the suspect in the open area without being alerted.
- To provide help and support for the driver assistant system.
- To detect and track uncontrolled vehicle, thief or terrorist running on border, highway or in the forest area.
- To detect and monitor the manufacturing and production industries.
- To monitor traffic flow and analyze the traffic volumes and pathways.

1.2. Importance of cloud and BigData in new era of thermal video surveillance

The thermographic sensors sense infrared radiation which are installed in forward looking infrared cameras for detection of infrared radiation that creates a picture [16,17,24]. With the help of these infrared pictures, pilots and drivers steer their vehicles at night (especially in fog, smoke or snow) and detect the warm object instead of cooler background. For example, the military thermal imager [16,17] is used for target acquisition that is applicable for reliable observation in long range object measurement during day/night in military and civilian aircraft. The accuracy of moving object detection method is of paramount importance to war fighters on the battlefield (ground, air, or sea). For this reason, air fighter, army, or military forces rely on such kind of electro-optical solutions. Such kind of system can also be implemented through cloud and IoT [20–23] that can show the capability to handle voluminous streaming of video data captured from dispersed devices (*IP*, *CCTV*, camera sensors, raspberry pi or IoT devices).

The modern surveillance technology is shifting gradually on cloud and Internet-of-Things (IoT) to observe the real-time situation using sensor based networks or technology such as Raspberry-Pi. In literature, very few cloud-IoT based services have been investigated for handling BigData [18,19]. The cloud-IoT and BigData based technology enables centralized monitoring of objects, and other activities to manage all the operations taking place in surveillance area such as border, traffic, sea, underwater surveillance, healthcare, operation theatre, and restricted zones. It can also observe the hill-area, flood-area, fired zone, and deep zones through drone or robot. It also helps in capturing video and send through sensor or Wi-Fi technology to the destination then detect and track the behavior of person, robot, vehicle, or other suspicious of object. With the help of infrared technology [20], the suggested work can also be applied to observe the behavior of hospitalized patient's during night time even when light is turned off. Such systems may bring exceptional efficiency to identify and detect leakage in oil/gas pipeline, underwater or sea, target tracking, crack detection, etc. Now a days, researcher institutes and software industries are concentrating on such solutions through IoT. These systems deliver better control over the operational process in optimized time period. The safety, reliability, efficiency, time and storage-cost are some major key-features used to measure performance with IoT and cloud services [21–23] in the surveillance domain. In addition, BigData, cloud and IoT easily integrates data from electronics devices such as fitness band into hospital systems, healthcare chip in patients for gathering more data or video stream from various sensors, social networks, airlines, hospitality, etc. The IoT in healthcare domain provides various services using implanted medical devices, wearable external medical devices, and stationary medical devices. Such kind of progressive data that consist of every information regarding any system (like plane, ship, satellite, etc.) is able to develop huge amount of data. So, we need to manage and process such kind of data using BigData and cloud technology [20,22–24]. The technologies used to handle such huge amount of data are Hadoop, HDFS, MapReduce, Apache Spark, Pig, MangoDB, NoSQL, etc.

The advantages of thermal imaging, related to lack of visibility, soft shadows, dust, mist, snow, fog, dynamic issues and illumination variations, are given below.

- Ability to deal with challenging miscellaneous background.
- Help in controlling of ever-increasing violence, vandalism and terrorism.
- The emerging levels of throughput and sensitivity of high-resolution based infrared sensors having lightweight as well as less expensive too.
- It provides a unique ability to visualize in the darkness that act as an active tool for intelligent security and persistent video surveillance applications.

2. Literature review

In literature, enormous approaches are available for moving object detection and tracking in video stream. Motion based information plays a crucial and very important role in the detection process. In literature several approaches and algorithms have been developed based on the background subtraction. Wren et al. [25] modeled the background independently at every pixel's location based on Gaussian probability density function (*pdf*) on previous pixel values. McHugh et al. [26] proposed a model using adaptive threshold technique using non-parametric background model and foreground model based on spatial information. Stauffer and Grimson [27] developed a Gaussian mixture model (*GMM*) based method in which each pixel is modeled individually using three to five consecutive Gaussian mixtures. This work is improved by Lee [28] by applying wiener filter and learning scheme. Then, Haque et al. [29] improved both [27,28] by introducing another modeling and learning method. Further, Yadav et al. [3,30] and Yadav has [31] has also improved the results of the *GMM* [27,29] by introducing another distance estimation method and post-processing technique. Jung [32] has proposed a trimmed mean based background model using statistical descriptors. This trimmed mean is capable enough to avoid noisy information that can also be helpful in extraction of foreground pixels. The pixel ratio is used to classify the current state of each pixel. Due to sudden changes in the scene, performance of detection is still lagging. Zhou et al. [33] has developed a framework for detecting **c**ontiguous **o**utliers in the **lo**w-**r**ank representation (*DECOLOR*) in video frames. In this method, outlier detection avoids complicated background motion. Decolor works in batch mode, which is not suitable